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AND CROSS-MODAL SENSORY TRANSFER IN KINDERGARTEN

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Donald Melcer
Major professor

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THE RELATIONSHIP BETWEEN FIELD DEPENDENCE/INDEPENDENCE AND CROSS-MODAL SENSORY TRANSFER IN KINDERGARTEN AND FOURTH-GRADE CHILDREN

By

Margaret Elizabeth Griffin

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ABSTRACT

THE RELATIONSHIP BETWEEN FIELD DEPENDENCE/INDEPENDENCE
AND CROSS-MODAL SENSORY TRANSFER IN KINDERGARTEN
AND FOURTH-GRADE CHILDREN

By

Margaret Elizabeth Griffin

The focus of this study was the relationship between field dependence/independence as measured by the Children's Embedded Figures Test (CEFT) and cross-modal transfer ability as measured by Cross-modal Sensory Transfer Tasks 1, 2, 3, and Combined Scores. Subjects were 60 children from Clayton County, Georgia, public school system, 30 of whom were enrolled in kindergarten (15 boys, 15 girls) and 30 in fourth grade (15 boys, 15 girls). The children's scores on both measures were compared using Pearson correlations, and a MANOVA procedure was used to test the effects of grade and gender of subjects on the relationship between the two measures. Data analysis revealed that there was a positive and significant relationship between the two measures and that there was a significant main effect for grade of subject but not for gender of subject.

The purpose for comparing a measure of field dependence/ independence with a measure of cross-modal transfer was to help to establish an empirical base for the notion that both abilities are manifestations of an underlying function, the ability to isolate and use essential features of an object. Ability to isolate essential

features has been related to numerous cognitive and personality traits and has been shown to affect family functioning, group functioning, and career choice. An understanding of the interrelationships of measures of ability to isolate essential features and the process of development of the ability has implications for the study of the individual, the family, the classroom, and the structure of various social groups.

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CHAPTER I

INTRODUCTION

Introduction

Perception in human beings is basic not only to the understanding of the individual, but also to the understanding of human social groupings. Perception can be studied as an information-processing mechanism by which humans gather and translate messages about the physical and social environment and an intermediate or transitional stage of information transfer to the cognitive domain. The perceptual process at its inception is the permeable boundary or line of demarcation at which the individual human system interfaces with its physical and social world. As the perceptual systems interact with the cognitive systems within the human mind, a feedback system develops by which the individual may selectively scan the environment and use information collected to build a store of knowledge about the world.

Humans obtain information about the environment through various sensory modalities such as skin (pressure and heat), eyes (light and pressure), ears (vibration and pressure), nose (chemicals and pressure), tongue (pressure and chemicals), and a variety of proprioceptive cues from muscles, eyes, and ears. Most information comes to us as a multi-sensory experience. Eating, as an example, often includes stimulation of an array of sensory organs. Humans, particularly when they are young, often explore the world in a multi-sensory fashion--tasting, smelling, touching, looking, and listening. Piaget (1969) and other developmental theorists have postulated that this multi-sensory exploration process, which combines sensory information with muscle movement, is basic to the development of the earliest thought patterns in humans. It is on these patterns that later thought and information-processing ability builds.

Piaget (1969) stated that early in the sensory-motor exploration of the world, a child begins to create a sense of "thingness" out of a series of explorations of any given object. The child, in effect, has isolated the essential features of that object that carry across two or more perceptual modes. As the child develops further, language labels for objects allow the child to have shared meanings with others for the essential "thingness" of an object. These language labels incorporate not only the individual's sense of "thingness," but also impose familial and cultural meaning onto the individual's unique interpretation of sensory-motor experience. The blending of individual and cultural interpretation of experience via the use of language is one of the bases for both similarity of reported perceptual experience across persons within a social group and individual differences (Gibson, 1967). This blending is one of many factors that adds to the difficulty of studying the nature of essential perceptual features ("thingness") of an object in a group of persons who are somewhat sophisticated in the use of a common language. The interaction between cultural meanings/language and individual meaning is often impossible to untangle. Therefore, it is important for students of human development to understand as much as possible about the early development of the various cognitive and perceptual processes that underlie and support the ability to know the essential "thingness" and isolate its features in order to be able to begin to determine what facets of our perceptual and cognitive ability are inherent and what humans must learn to develop and to understand the world.

Conceptual Framework

Humans live as individuals, members of a family, and members of social groups. Depending on the context of the situation in which a given person may be operating, perception of information about his/her and others' actions upon and reactions to the environment may differ. Information based on individual perception and experience is highly idiosyncratic and not easily communicated to others. Actions and meanings of those actions within a family group or social group, although not devoid of individual meaning, reflect more mutually accepted and understood interpretations. It is the similarity of understanding of perceptual information that is a factor in binding the group together into a unit that has an identity of its own beyond the individual identities of its members. This unit may be a family, a peer group, or a class of children, among others.

Study of similarities in perceptual ability and interpretation of perceptual information have revealed that there is, indeed, some evidence of perceptual similarity among family members (Witkin & Goodenough, 1981) and among social-class groups (Derevensky, 1977).

It is known that the type of perceptual style of members affects group structure and function. For example, a number of studies have shown that some people are more analytic (as opposed to global) in their interpretation of perceptual stimuli but are less adept in using information obtained from others (Busch & DeRidder, 1973; Linton, 1955). People who use an analytic perceptual style are also more autonomous in their interpersonal relationships and are more responsible, self-reliant, and able to think for themselves than those who use a more global or nonarticulated style of perception (Witkin & Goodenough, 1977).

The perceptual and cognitive style labeled field dependence/independence is a part of the global versus articulated or analytic style. Field independence (analytic) is the ability to cognitively restructure information from a perceptual experience and manifests itself in an ability to separate objects from context and align oneself to the vertical (Witkin & Goodenough, 1981). Field dependence (global) is manifested in the inability to disembed or align with the vertical and relates to dependence on social and other external referents (Witkin & Goodenough, 1981).

In a nursery school setting, it was observed that children who adapted most easily to school and had the least problem separating from parents were also those who rated most highly on tests of perception involving disembedding, a factor in the articulated (field independent) perceptual style (Olesker, 1978). The more analytic a person's perceptual style, the more at ease that person will be in a large, unstructured group setting (Steingart et al., 1975). In group settings, those groups that have persons manifesting a global perceptual style are more effective in conflict resolution than those groups without global-style members (Oltman et al., 1975).

Research also showed that for both educational and occupational choice, the type of perceptual style influenced the choice made by individuals. Global-style persons tend toward human-services work, and articulated-style persons tend toward careers emphasizing independence in work habits (Witkin et al., 1977). For example, psychiatric nurses tended to be more global in perceptual style, while surgical nurses were more analytic (Quinlan & Blatt, 1972). Pilots (Cullen, Harper, & Kidera, 1969) and engineers (Barrett & Thornton, 1967) tend to be more articulated in perceptual style, while writers (Witkin & Goodenough, 1977) tend toward a more global style.

Within the family unit, use of global versus articulated perceptual style also has implications for variation in functioning. For example, in early studies of perceptual and cognitive functioning, Witkin and his colleagues (1962) speculated that child-rearing practices affected the development of perceptual and cognitive styles. Specifically, they suggested that parents who encouraged autonomous functioning in their children were also promoting development of a more articulated style (related to field independence), while more authoritarian child-rearing practices led to a more global style (related to field dependence) in the children.

Research involving mothers and sons (Dyk & Witkin, 1965) supported the early hypotheses about relationships between cognitive and perceptual style and child-rearing practices. This research also revealed that parents of global-style children also used more severe methods of training and disciplining their children than did parents of analytic-style children. Mothers of children who demonstrated low disembedding ability gave commands to their children more often than mothers of children with high disembedding ability (Busse, 1969). Children with low disembedding ability had parents who were uninvolved in training their children or did not allow the children to help themselves in learning situations (Busse, 1969).

In homes where family interactions are strongly dominated by parents, children tend to be more global in perceptual style (Witkin & Goodenough, 1981). Another study revealed that mothers of field-dependent children were observed to be nonspecific and repetitive in the comforting of their children during infancy, which was said to hinder the development in the child of ability to discriminate among needs and feelings (Dyk, 1969).

The teaching of sex-roles is a primary function of the family, especially parents.

> To the extent that children identify more with the same-sex than with the opposite-sex parent, sex-role modeling may be a major factor in the development of sex differences in field dependence-independence. If so, children (especially boys) of fathers who do not enter actively into the child-rearing process are likely to be relatively field dependent, and children (especially girls) of mothers who do not enter actively into the child-rearing process are likely to be field independent. (Witkin & Goodenough, 1981, p. 87)

For girls, the greater the influence of the father on family decisions, the more field independent they were, while the greater the influence of the mother on family decisions, the more field dependent they were (MacEachron & Gruenfeld, 1978). For boys, families with strong paternal involvement tend to have sons who are field independent (Busse, 1969). Father absence has been associated with greater field dependence for both boys and girls, while the evidence on mother absence is inconsistent (Schooler, 1972). According to a study by Holtzman, Diaz-Guerrero, and Swartz (1975), the nuclear-family structure in the United States tends to produce greater field independence than does the extended family.

The cognitive development of individuals is influenced by their ability to disembed.

> Although field-dependent and field-independent people do not appear to differ with regard to immediate percept induced by most stimuli, field-independent people seem better able to achieve a different percept--when required to do so by situational demands or inner needs--through the restructuring of their initial perceptual experience, at least with respect to spatial-configurational material. In contrast, among field-dependent people the prevailing organization of the perceptual field is likely to be adhered to as given. A difference in restructuring ability between field-dependent and field-independent people, similar to that observed in their perceptual activities, is also evident in their intellectual functioning. (Witkin & Goodenough, 1981, pp. 23-24)

Research has demonstrated that field-independent people perform better than field-dependent people on tests of speed of closure (Gough & Olton, 1972), conservation (Piaget, 1969), representation of the horizon (Willemsen et al., 1973), and spatial-visualization tasks (decentration) (Gough & Olton, 1972). Ability to break a mental set (Busse, 1968) and ability to use a hypothesis-testing approach in visual-discrimination tasks (Nebelkopf & Dreyer, 1973) are also related to field independence. Field independence has been positively correlated with spatial and performance items on IQ tests such as the

WISC and WAIS but has not been found to correlate with verbal items (Witkin & Goodenough, 1981).

Field dependence/independence in cognitive and perceptual functioning has been demonstrated to relate to a wide variety of characteristics. A number of personality factors have also been studied in relation to field dependence/independence. One of the major differences between field-independent people and field-dependent people is their relationship to others. Witkin (1978) reported that field-independent people are able to function more autonomously of others. Field-dependent persons are more attentive to social cues and tend to watch faces more often and more closely than do field independents (Konstadt & Forman, 1965). Words with social and emotional connotations are more salient to field-dependent persons (Minard & Mooney, 1969). Field-dependent persons also prefer to be physically near the persons with whom they are interacting (Witkin, 1977). In contrast, field-independent children spend more time in solitary play (Witkin & Goodenough, 1981). It was more difficult for field-dependent persons to display hostile or aggressive feelings (Dyk & Witkin, 1965).

Research with both clinical and normal populations has revealed that the global versus articulated style of perceiving is related to a number of factors associated with psychological development. Witkin (1965) used figure drawings as a means to assess articulation of body concept and found that field-independent children produced drawings that indicated a much more highly developed sense of body concept. The drawings were more realistic and more detailed. Persons who use more highly specialized defense mechanisms such as isolation are generally field independent (Witkin et al., 1962). Field dependence (global) seems to be related to a number of pathologies such as alcoholism (Karp et al., 1965), obesity (Karp & Cardes, 1965), asthmatic children (Fishbein, 1963), enuretic children (Scallon & Herron, 1969), cardiac disorders (Soll, 1963), hysteria (Zukman, in Witkin et al., 1971), and catatonics (Janucci, in Witkin et al., 1971). The Witkin group (1971) reported that types of pathology common to field-independent (articulated style) persons included delusions, expansive and euphoric ideas of grandeur, outward direction of aggression, paranoia, obsessive-compulsive characteristics, and bizarre attempts to maintain identity.

Based on the information presented above, it is obvious that the presence of the perceptual and cognitive style labeled field dependence/ independence in each individual has far-reaching consequences for the development of that individual as a unique human being, a family member, and a member of various social groups. A vast array of human functions, such as cognitive, social, and personality, develop in relation to field dependence/independence. A change in one function signals a change in many other functions.

> Because the field-dependent and field-independent cognitive styles are different in their adaptive consequences, it need not be surprising that people develop cognitive styles which are adaptive to the demands of the life situations with which they must cope. Conversely, cognitive styles have been shown to cause people to gravitate toward life situations to which their styles are suited. Achievement of adaptive correspondence between cognitive styles and life circumstances is thus a two-way street. Moreover, reflecting their salience as a developmental force, cognitive styles guide the formation of modes of

> behavior in people which are compatible with their styles. And, finally, a person's cognitive style may influence others to behave toward him in a manner which suits his cognitive style and is thereby helpful to him in his interpersonal relations. (Witkin, 1978, p. 30)

One of the other perceptual abilities to which the field dependence/independence trait is related is cross-modal sensory transfer. This is the ability to use information gained from one modality to make a decision about information gained from a second modality. The ability to disembed visually, one factor of field dependence/independence, is related quite closely to both tactile and auditory disembedding and transfer (Witkin et al., 1971). Gibson (1966), a primary researcher in the field of cross-modal transfer, has pointed out that the understanding of those mechanisms by which perceptual information can be transferred between perceptual subsystems is essential to a basic knowledge of learning, attention, and perception itself. Gibson's theory of cross-modal transfer holds that information acquired via one sensory modality

> is not stored exclusively in a modality-specific form or "place." Instead, information that is retained by the nervous system is made "supramodal"; that is, it is transformed into a configuration or other state that is not specific to the characteristics of any single subsystem. Essential properties and configural relations in the information are extracted, schematized, and held in schematic or abstract form. (Abravanel, in Walk & Pick, 1981, p. 72)

This ability to isolate an essential property or relation is hypothesized as being much the same as the ability to disembed found in field-independent people. The lack of ability to organize and restructure perceptual information seen in field-dependent people may be related to relative inability to transfer essential features and relationships in a cross-modal manner. As Abravanel (1981) indicated,

> In large measure, perceptual development consists of learning to attend to the most relevant features and relations of objects < events; of learning how to explore in order to canvass global information and to pick up more precise data. As these functions of perception develop, the organism becomes a more precise, astute, and specialized perceiver who is capable of making more differentiated and accurate judgments. (p. 103)

The development of cognition is said to parallel the development of perception. Piaget (1969) has postulated that perception and cognition are interrelated processes that work in tandem to assist the individual in achieving an understanding of a given experience. Piaget called this process equilibration. Just as Piaget's levels of cognitive development are organized in a hierarchical fashion, so are the accompanying perceptual stages. The interaction between perception and cognition leads to intellectual development in the individual. Piaget (1969) noted that the study of interrelationships between perceptual and cognitive phenomena and the changes in the nature of those interrelationships across development of individuals was crucial to the understanding of the development of the intellect.

Therefore, to study the nature of the structures that the individual perceptual and cognitive system creates to deal with early multi-sensory experiences with objects, it is wise to choose children as subjects for study. Language as a tool for communication and mental organization exerts the least influence on young children who still rely heavily on individual sensory-motor schemes to organize their responses to the world (Piaget, 1969). However, it is also difficult to communicate lengthy instructions for the purpose of eliciting a standard response to children between birth and 4 years of age. Early-elementary-school-aged children have attained a level of language development that is sufficient to allow them to follow instructions, yet they have not lost the idiosyncratic language associated with early childhood. Kindergarten-aged children, in general, are at a point in their development during which they are making the fullest possible use of sensory-motor information combined with the idiosyncratic use of cultural labels (end of preoperational stage) (Piaget, 1969).

By fourth grade, most children are able to represent mentally an event in the absence of a real-world referent, although they are not able to deal with the abstract (concrete operations) (Piaget, 1969). They are able to use cultural labeling systems to generate names for categories of objects and are able to articulate the essential "thingness" or features of an object (Gibson, 1967). Their cognitive abilities are qualitatively different from the kindergarteners', but they have not yet reached the sophistication of adult thought.

Due to the above-mentioned characteristics of the kindergarten and fourth-grade age groups, these two groups of children seem to represent populations that demonstrate age-group characteristics that bear directly on the study of the development of perception of essential features of objects. The examination of differences between these groups in their ability to isolate and manipulate "thingness" of an object will also shed light on the process of development of this perceptual and cognitive ability.

The framework upon which this study is designed is a combination of the notions about perceptual development put forth by the

Witkin group, Gibson, and Piaget. The author is seeking to establish (a) that field dependence/independence and cross-modal transfer ability in school-aged children are related abilities based on the idea that both abilities depend on the skill with which an individual can isolate and use essential features of an object or event, and (b) that the development of both abilities parallels that of other types of cognitive and perceptual processes as set forth in the developmental stages of Piaget.

Rationale

For a number of years, researchers have been intrigued by the ability of most humans to generalize from perceptual experience and use that generalization to solve a second perceptual problem, i.e., to use the ability to isolate essential features of an object. Witkin and his colleagues (1965) have studied a perceptual phenomenon they called field dependence/independence. One of the abilities in the cluster associated with field dependence/independence is the ability to separate object from field or isolate an object from its context. This type of behavior is measured by one of several "embedded figures tests" developed by the Witkin group. A second perceptual phenomenon, labeled cross-modal transfer, has been studied by a number of researchers including Gibson (1967). Cross-modal transfer involves the ability to experience an object with any single sensory modality and subsequently to identify that object using a second sensory modality. It appears that both embedded figures tests and cross-modal sensory transfer tasks are tapping the same perceptual and cognitive process--that of isolating the essential features of an object and using them to judge other perceptual stimuli as same or different (Witkin et al., 1971). Therefore, it seems logical to use these two well-documented processes for tapping the perceptual and cognitive system in tandem to study the development of the ability to isolate and use essential features of objects.

Purpose of the Study

The purpose of this study was threefold. First, the researcher examined the relationship between field dependence/independence and cross-modal sensory transfer using a comparison of scores of subjects on tests of each trait. Two questions at this point were: did a relationship between the two traits exist and if so, what was the nature of the relationship? As a relationship did exist between the two traits, a second purpose of the study was to examine the possibility of a developmental trend in the relationship by comparing age-group scores on the measures of both traits. The possibility of a developmental trend was suggested by previous research in which perceptual ability increased with age (Kleinman, 1979; Witkin et al., 1967). Also based on previous research, a third focus of the study was designed to examine the possibility of any gender-related differences that might appear across age-groups, within age-groups, across measures of traits, and/or within the relationship between the two sets of measures, as gender differences in ability in field dependence/independence and cross-modal sensory transfer have been found in some populations (Vaught, 1965).

Statement of Research Questions and Hypotheses

The primary purpose of this study was to examine the relationships and nature of those relationships between scores on measures of field dependence/independence and cross-modal sensory transfer for kindergarteners and fourth graders. Research in both areas seemed to indicate that the mechanism allowing both processes to take place represents a level of ability to discriminate the essential features of an object (Gibson, 1967; Witkin, 1965).

Questions raised by this type of inquiry were: (a) speculation as to the relationship(s) between measures of performance on tests of field dependence/independence and cross-modal sensory transfer ability, (b) the relationship of age and/or gender of subjects to scores on measures of ability on tests of field dependence/independence and cross-modal sensory transfer, and (c) the relationship of age and/or gender of subjects to the suspected relationship between cross-modal sensory transfer ability and field dependence/independence.

Research Questions

The following three questions represent the main directions of the study.

1. Are scores of kindergarten and fourth-grade children on tests of field dependence/independence and tactile-visual cross-modal sensory transfer, as measured by the Children's Embedded Figures Test and three Cross-Modal Sensory Transfer Tasks, respectively, related, and if so, what is the nature of that relationship?

2. Is there a developmental trend in the above-mentioned scores and/or their relationships, and if so, what is the direction of that trend?

3. Is gender of subject a factor in the scores obtained on measures of either or both field dependence/independence and tactile and visual cross-modal sensory transfer or in the relationship between scores?

Hypotheses

The following hypotheses were generated to guide the direction of the study.

1. Scores for Cross-modal Sensory Transfer Task 1 (visual-to-visual matching) are positively related to scores for Cross-modal Sensory Transfer Task 2 (visual-to-tactile matching).

2. Scores for Cross-modal Sensory Transfer Task 1 (visual-to-visual matching) are positively related to scores for Cross-modal Sensory Transfer Task 3 (tactile-to-visual matching).

3. Scores for Cross-modal Sensory Transfer Task 2 (visual-to-tactile matching) are positively related to scores for Cross-modal Sensory Transfer Task 3 (tactile-to-visual matching).

4. Scores for the Children's Embedded Figures Test are positively related to:
    a. Cross-modal Sensory Transfer Task 1 (visual-to-visual matching) scores
    b. Cross-modal Sensory Transfer Task 2 (visual-to-tactile matching) scores
    c. Cross-modal Sensory Transfer Task 3 (tactile-to-visual matching) scores
    d. Cross-modal Sensory Transfer Combined Tasks scores

5. Fourth graders, as a group, will perform better than kindergarteners on:
    a. Cross-modal Sensory Transfer Combined Tasks scores
    b. Children's Embedded Figures Tests scores

6. Males, as a group, will perform better than females on:
    a. Cross-modal Sensory Transfer Combined Tasks scores
    b. Children's Embedded Figures Tests scores

Definitions of Terms

Field dependence/independence--a hypothetical continuum of behavior used to label skill in the ability to separate objects from context or to see objects as discrete from background. Field dependence is the lesser ability. Field independence is the greater ability.

Tactile-visual (visual-tactile) cross-modal sensory transfer--the process involved in the intake of information about an object tactilely (visually) and the use of that information to make a decision about the object using the visual (tactile) mode.

Perception--the process by which information about the environment is moved through the human nervous system. This process is initiated in the sensory organs and combines with previously acquired mental structures in the brain to produce awareness of the environment.

Proprioceptive perception--reaction to stimuli originating within the organism (e.g., muscle tension, balance).

Assumptions

The following assumptions gave implicit direction to the study.

1. Perception and cognition are interrelated processes.

2. Perception is one of the primary mechanisms of information exchange for the human system.

3. The two instruments (Children's Embedded Figures Test and the three Cross-modal Sensory Transfer Tasks) chosen to measure perceptual and cognitive ability do, actually, measure those abilities.

4. The kindergarten children in the sample were actually operating on a preoperational level of cognitive development.

5. The fourth graders in the sample were actually operating on a concrete operational level of cognitive development.

CHAPTER II

REVIEW OF LITERATURE

This review consists of three parts. The first is a description of the construct of field dependence/independence and a summary of selected research dealing with a particular test (Children's Embedded Figures Test), which is purported to measure children's capacity to disembed objects from context, one of the facets of field dependence/independence. The second section covers research dealing with ability of children to perform Cross-modal Sensory Transfer Tasks involving visual and tactile sensory modalities. The third section of this review presents research and commentary concerned with the interrelationships of perceptual abilities.

Research presented in this review deals specifically with those areas of research in field dependence/independence and cross-modal transfer that bear directly upon the study. The following review of literature represents an attempt to present background information about the two measures (Children's Embedded Figures Test and Cross-modal Sensory Transfer Tasks 1, 2, and 3 and Combined) used in this study, particularly the use of the measures with early-elementary-aged children and the results of those studies. Previous research involving the use of these two measures has provided direction in developing both the research questions and the design of this study. Conclusions of previous research into cognitive and perceptual development led to the use of the Children's Embedded Figures Test and the Cross-modal Sensory Transfer Tasks 1, 2, and 3 and combined in tandem to explore interrelationships in cognitive and perceptual functioning.

Field Dependence/Independence

In 1954, Witkin and his colleagues introduced the field dependence/independence dimension of cognitive and perceptual style as part of a theory of individual differences. The primary interest of the Witkin group (1954) was in the psychology of perception, particularly in distinguishing between global and analytic ways of perceiving objects and events. The field-independent person, as described by Witkin, is likely to be analytic and tends to separate elements from background or context. Such persons also are able to relate to the physical upright despite a tilt in the field or in body orientation. The field-dependent person tends toward a global approach, attending to wholes rather than parts and being more sensitive to social cues. Witkin defined the field dependence/independence continuum as "an analytic, in contrast to global way of perceiving [which] entails a tendency to experience items as discrete from their backgrounds and reflects ability to overcome the influence of an embedding context" (Cross, 1976, p. 114).

There are two primary foci for research involving the ability to disembed: "(1) the relation between disembedding ability in perception and disembedding ability in intellectual functioning; and (2) the relation between disembedding ability and structuring ability" (Witkin & Goodenough, 1981, p. 17). The ability to disembed was seen as relating to cognitive tasks in which the problem to be solved involved separation of elements from a context. It was also seen to relate to perceptual tasks. Field-dependent subjects also had difficulty with "that particular class of problems in which the solution depends on taking an element critical for solution out of the context in which it is presented and restructuring the problem material so that the element is now used in another context" (Witkin & Goodenough, 1981, p. 17). This evidence seems to indicate that the ability to disembed spans both perceptual and cognitive domains in an individual.

The relationship between disembedding and structuring is based on the hypothesis that there is a tendency to deal in a more active or more passive way with the field in each individual (Witkin & Goodenough, 1981). The field-independent person would demonstrate ability to impose a structure on a field that lacked an inherent organization, while the field-dependent person would experience lack of organization.

Types of Tests to Measure Field Dependence/Independence

Three types of tests were developed by Witkin and his colleagues (1954) to measure the field dependence/independence dimension. The common element in all the tests is the extent to which people are influenced by the surrounding visual field (Cross, 1976). The tests are the Body Adjustment Test (BAT), the Rod-and-Frame Test (RFT), and the Embedded Figures Test (EFT). The BAT and RFT involve alignment of the body and the alignment of a luminous rod, respectively, to the vertical. The EFT involves the isolation of a simple geometric form from a complex one. The first two tests (BAT and RFT) involve the use of both proprioceptive and visual cues, while the EFT involves only the use of visual cues. Other researchers have studied field dependence/independence using various other sensory modalities than those studied by the Witkin group and have found that field independents are able to isolate melody line from a complex composition and that field dependents are more aware of social cues (Cross, 1976).

Several other researchers have developed tests based on figure/ground relationships. Frostig and her colleagues developed the Marianne Frostig Developmental Test of Perception in the early 1960s as a battery to test perceptual skills of children ages 3-8 years and as a diagnostic screening test (Maslow, Frostig, Lefever, & Whittlesey, 1964). Subtest Z, Figure-Ground, is the only subtest of the five included in the battery that relates directly to ability to disembed. Reliability of the test is low, cited in the .30-.50 range, and validity is moderate with correlations of .40-.50 to reading scores (Buros, 1972).

Another test, the Southern California Figure-Ground Visual Perception Test, was developed by Ayres in 1966 to test visual perception of 4-10 year olds of a figure against a background (Ayres, 1966). The test consists of 18 paired items, 9 overlapping-outlines pairs, and 9 embedded-figures pairs. Reliability of the test is low, at .37 to .52 on test-retest evaluations (Buros, 1972).

The Children's Embedded Figures Test (CEFT) used in this study was developed by Karp and Konstadt in 1963 and revised in 1971. It consists of two subtests, one with a "tent" as the stimulus figure (11 items) and one with a "house" as the stimulus figure (14 items). The score for the test is the total of the two subtests. (See Chapter III, Instruments.) The test stimuli are cardboard geometric shapes and geometric drawings in which the child must locate the embedded shape that corresponds to the test stimuli. The CEFT is administered individually and is designed for children between the ages of 5 and 12 years. The CEFT is the most widely used of the embedded-figures tests for children due to handy construction (small cards as opposed to puzzles) and ease of transportation of materials.

Several children's versions of the Embedded Figures Test have been developed. Goodenough and Eagle (1963) developed a children's form of the EFT called the Children's version of the Embedded Figures Test (CHEF). This test is appropriate for subjects as young as 5 years. Familiar objects such as a man, boat, and car are substituted for simple geometric forms and are embedded in knob puzzles. This test is not used currently because of its bulky construction and the difficulty associated with transporting the test.

Research on Children and Field Dependence/Independence

The majority of research involving the use of the Witkin group's three tests has been conducted using subjects over 10 years of age. The field dependence/independence dimension is difficult to study in young children due to the egocentric nature of their relationships to the environment. Very little research with children using the BAT or the RFT has been conducted.

Ghuman (1977) used the Children's Embedded Figures Test as part of a battery of tests assembled to explore social and cognitive development. He found that middle-class children performed better than working-class children on the CEFT. CEFT was positively related to cognitive measures (Piagetian tasks) but not to the personality measures used. There was no difference between performance of boys and girls (ages 11-12 years) on the CEFT.

Connor, Schackman, and Serbin (1978) found that first-grade children who received training in visual-spatial disembedding could improve their performance on the CEFT. The researcher used half of the test items as a pretest and half as a posttest. The girls' performance improved significantly more than did the boys' as a result of training.

Gildemeister and Friedman (1978) studied first graders of exceptionally high and low verbal ability in relation to visual-analysis ability. The high-verbal-ability group performed better on the Spatial Relations subtest of the Primary Mental Abilities Test but did not differ significantly from the low-verbal-ability group in performance on the CEFT. The researchers felt that this finding gave more support for the hypothesis that the CEFT measures abilities that are not related to verbal ability.

Damusis and Desjarlais (1977) reviewed literature on field dependence/independence and educational policy. They found that the literature supports the ideas that field-independent children can analyze and restructure problems and can take another's point of view. This leads to greater social ability. The researchers concluded that in an educational setting, children high in field independence will excel in spatial relations and that these children will be more intrinsically motivated. On the other hand, research on field-dependent children showed that they will be more inclined to respond to contingencies of social reward.

Age and Field Dependence/Indepencence

Witkin, Goodenough, and Karp (1967) demonstrated in two longitudinal studies in which subjects ranged in age from 8 to 24 years that the field dependence/independence dimension was stable across time. There is a trend toward increased performance (i.e., toward field independence) on all three types of tests up to age 17, with a slight decline in performance through age 21 and then stability through at least age 24. There also seems to be a sharp decline in field independence in post-retirement years (Schwartz & Karp, 1967). Studies on children under 8 years presented contradictory findings.

Gender and Field Dependence/Independence

Although sex differences in performance on the field dependence/ independence measures have been noted for older children and adults (Vaught, 1965), sex differences in performance have not been noted for children in the 4-8 year range (Maccoby et al., 1965) or in geriatric populations (Schwartz & Karp, 1967). Gender differences in performance on BAT and RFT may be related to ability to perform well on spatial-relationships tests (Gardner, Jackson, & Messick, 1960). Sherman (1967) postulated that the reason for superior male performance on tests of spatial ability and on BAT and RFT is due to a sex bias built into toys that allows males more practice in perceiving spatial relationships.

Relationship of Field Dependence/ Independence and Schooling

It has been suggested by researchers that ability in art and music, both disciplines requiring skill in restructuring, may be enhanced by training that encourages analytic processes (Witkin et al., 1977). First-grade children who received 7 months of musical training by the Kodaly method showed significantly more field independence than the control group, who received no training (Hurwitz, Wolf, Bortnick, & Kokas, 1975).

Preschool-age children showed significant improvement in field independence after a year's viewing of games involving perceptual analysis that are part of the Sesame Street television series (Ball & Bogatz, 1970). Children who participated in Project SEE, a perceptual, analytical training program for kindergarteners and first graders, showed a generalized enhancement of restructuring ability and improved performance on embedded-figures tests after 1- and 2-year training programs (Dolecki, 1976).

Cross-modal Sensory Transfer Ability

Gibson (1967) wrote that "cross-modal transfer carries the implication that some discrimination has been learned by presentation in one modality and that the discrimination can be made, without specific practice, when the objects are presented in a different modality" (p. 220). Gibson (1967) also classified "higher orders of properties of stimulation which are not sensation specific" (p. 219) as amodal and asserted that "many distinctive features of objects and events (corners, motions, temporal patterns, and transitions)" (p. 219) may very well be products of amodal or cross-modal perceptions as opposed to a single mode of perception. Although cross-modal or intermodal transfer has been demonstrated to exist in tactile-auditory, auditory-visual, and visual-tactile pairs, it is only the visual-tactile transfer that bears directly on this study.

In studies of visual-tactile matching of form it has been demonstrated that for all age groups and for both sexes visual matching is superior to tactile matching and that "discrimination of form is more efficient when standards and comparisons are presented visually" (Walk & Pick, 1981, p. 118). It has been noted that visual and tactile (haptic) exploratory patterns contain elements that are similar (two eyes, two hands exploring in tandem) and different (hands are not required to work as a pair) and unique (hue perception is visual only). This points to the fact that only certain types of information can be perceived intermodally. Study of information transfer between sensory modalities--both the types of information available for cross-modal transfer and the processes involved in the transfer--is basic to the understanding of both the nature of intersensory integration and the development of intersensory integration (Walk & Pick, 1981).

Theories of Cross-modal Transfer

One of the early conceptual frameworks for the study of the development of cross-modal matching was developed by Birch and Lefford (1967). They argued that the level of cross-modal matching ability at a particular age level corresponds to the degree of intersensory organization at that age level. Movement from dependence on proximal stimulation (dominance in the tactile mode) to distal stimulation (dominance in the visual mode) was the process of perceptual development. This shift from tactile to visual dominance was accompanied by an increase in intersensory integration and in the ability to use intersensory transfer.

Piaget's theory of cross-modal transfer is a mediation theory. The build-up of representative schemata with increased age is accomplished through search for significant objects in the environment. The mediation of schemes common to both systems precipitates the interrelationships of visual and tactile perceptual systems. "The sensory scheme is a kind of referent to two modalities, making cross-modal transfer possible" (Gibson, 1967, p. 230).

J. J. Gibson's (1966) theory of perceptual development is an information-based theory. In Gibson's theory, no one sense presents more truthful or accurate information about a stimulus than any other; each is an information-seeking system that has equal potential for supplying the individual with knowledge of properties of objects. Gibson's theory is not developmental; he maintained that structure in perceptual experience is discovered, not constructed. Gibson coined the term "amodal" to describe those experiences and information that are the products of cross-modal or multi-sensory processes.

At present, the theory of Birch and Lefford is no longer used as a basis for research. The ideas of both Piaget and Gibson have been springboards for much research into the nature of cross-modal transfer, and both theories have empirical support. It is impossible at present to determine which of the theories, that of Piaget or that of Gibson, presents a more accurate description of the development of perception and, more specifically, the nature and development of cross-modal transfer.

Research on Children and Cross-modal Transfer

Walk (1965) found in comparing visual and tactile modes that symmetrical forms were differentiated more easily in the visual mode than were asymmetrical forms. In the tactile mode, neither type of form was discriminated more easily. He also found that by having subjects use both hands to explore figures the tactile experience became more similar to the visual experience in accuracy of perception. Rudel and Teuber (1964) found that in cross-modal matching tasks the number of correct visual-visual and visual-tactile matches was about equal for children ages 5 and 6 years old, but the visual-visual matches were favored by children ages 3 and 4 years.

Training for Cross-modal Transfer

Pick, Pick, and Thomas (1966) used printed and raised letter-like stimuli in a training study involving visual-tactile cross-modal matching. First graders were trained to discriminate standard forms by sight or by touch and then were trained for transfer to the other condition. Those groups of children who were trained to attend to differences in forms showed more cross-modal transfer.

Butler (1979) trained third and fourth graders in visual and haptic cross-modal transfer tasks. All subjects in this study scored high on measures of impulsivity. Haptic training decreased errors on visual measure, while visual training decreased errors on both the haptic and the visual measures. It was noted that presentation in the visual mode was more salient than presentation in the tactile mode for training in cross-modal transfer.

Blank and Bridger (1964) compared cross-modal concepts and cross-modal equivalence in children ages 3 to 6 years. They assumed that the children would have to be able to verbalize the transfer concept in order to solve the cross-modal transfer problems. Children as young as 4 years could make the transfers (visual-tactile matching and discovery of the concept of succession) required of them at a greater-than-chance level but could not verbalize the rules that governed the transfer. The children also either did not or could not make use of the rules for transfer when they were trained in the use of the rules. The researchers concluded that verbal mediation was not a factor in the transfer process.

Mode of Primary Presentation

Davidson, Pine, Wiles-Kettenmann, and Appelle (1981) compared retarded (mental ages of 5.5 years to 8.5 years) and nonretarded (nursery school, elementary school, and junior high) children on haptic and visual-matching tasks. Results showed that for both groups, stimulus complexity, presentation modality, and mental age affected accuracy of match. Presentations to the visual mode increased accuracy in matching.

In a study of cross-modal ability in first, second, and fourth graders, Fishbein, Decker, and Wilcox (1977) used a task involving location of a group of three geometric objects. The initial sensory input could be either visual or tactile, and the choice stimuli were photographs of the groups of objects. The choice stimuli were presented either simultaneously or successively with the photographs. Older children performed better than the younger ones. No difference was found between intramodal and cross-modal tasks, but performance was better for all age groups for the simultaneous-presentation condition than it was for the successive-presentation condition for both visual and tactile initial inputs. However, presentation of an initial visual-input stimulus increased performance for all ages. The researchers concluded that visual perceptions mediate performance in tasks where there are both visual and tactile inputs.

Jain and Sinha (1978) studied the effects of mode of presentation on accuracy of cross-modal matching. They found a significant difference between visual-tactile and tactile-visual conditions of presentation with the visual-tactile presentation yielding the greater number of accurate matches. The researchers suggested that initial information gained through the use of the visual mode is more useful in accomplishing tasks of cross-modal matching than is information gained through use of the tactile mode.

Relationship of Cross-modal Ability to Cognitive Functioning and Schooling

In a review of literature on cross-modal functioning, Derevensky (1977) found support for the notion that cross-modal functioning and the resultant sensory integration are related to reading achievement. For children beyond second grade, cross-modal ability was more highly related to high reading scores than was visual discrimination. Derevensky noted that results of studies showed that individual development of the child, sex of the child, socioeconomic status, and types of tasks used to measure cross-modal ability all affected the outcome of the studies reviewed.

Jarman (1978) studied fourth graders of high, normal, and low IQ in relation to their performance in cross-modal and intramodal matching ability in tasks with visual and auditory content. He found that there was an interaction between tasks and child's strategy for problem solving that determined competence in both cross-modal and intramodal tasks and that the interaction was positively related to IQ of the child.

Using blind, partially sighted, and sighted 4 to 7 year olds, Simpkins (1979) studied the effect of school experience on tactile discrimination. No significant differences were found on the basis of vision or gender; however, school experience had a positive effect on the ability to discriminate tactually in all groups.

Age and Cross-modal Transfer

In a study of developmental changes in haptic matching ability, Kleinman (1979) found that there was an increase in ability to match stimuli using haptic clues between kindergarten and second grade and then again between second grade and fourth grade. He cited increased exploration time and more efficient use of scanning strategies as factors in the improved ability across age groups.

A battery of tests for measuring cross-modal ability across three modalities was developed by Temple, Williams, and Bateman (1979). They found that age and developmental level were factors in determining a child's performance on cross-modal and intramodal tasks as represented by the tests selected for inclusion in the battery. The younger child and the learning-disabled child were less able to perform well on the measures tested for use in the battery. The sample included both normal and learning-disabled 6- and 8-year-old children.

Relationships of Perceptual Style and Cross-modal Transfer Ability to Other Perceptual and Cognitive Abilities

The study of field independence and cross-modal transfer has involved much research into the relationships between these constructs and their respective behavior correlates and other postulated cognitive and perceptual abilities. Such research helps to establish a framework for understanding the basic processes that underlie those behaviors labeled cognitive or perceptual and helps to point out gaps in the patterns of constructs that have been developed to explain mental processes.

Various studies have demonstrated that the Children's Embedded Figures Test scores used to measure field dependence/independence in children are related to a number of other measures of cognitive and perceptual functioning. Goodenough and Karp (1961) found the measures on the Embedded Figures Test to load the same factor as the WISC Block Design, Object Assembly, and Picture Completion subtests for 10 and 12 year olds. Pascual-Leone (1969) found that the CEFT also related to the performance tests of the WISC but not to the verbal-comprehension subtests. Field-dependent persons have been found to have better memory for faces (Konstadt & Forman, 1965). Field-independent persons have been found to be more creative (Stevens, 1969). Personality also seems to have some relation to field dependence/independence in that field-dependent children have a greater tendency to mental illness (Karp et al., 1965; Scallon & Herron, 1969) and are more easily influenced by social criticism and show less autonomous play (Crandall & Sinkledam, 1964).

Cross-modal transfer abilities have been shown to be related to reading ability, particularly in children over second-grade level (Derevensky, 1977). In children over second-grade level, spelling, language skills, and the Iowa Test of Basic Skills have been found to relate to cross-modal transfer ability in children (Early, 1976). Children with normal to high IQ were found to be better able to use training in cross-modal transfer skills (Jarman, 1978). Improvement in cross-modal transfer ability with age has been hypothesized to relate to brain development, specifically myelination of forebrain commissural neurons (Galin, Diamond, & Herron, 1977). Thus, it can be seen that field dependence/independence and cross-modal sensory transfer ability have been studied in relation to varied and numerous other aspects of perceptual and cognitive functioning.

CHAPTER III

RESEARCH DESIGN AND PROCEDURES

Introduction

The design for this quasi-experimental study was a combination of several simple correlational designs and a 2 x 2 factorial design (Campbell & Stanley, 1966). This combination of designs was chosen because of the flexibility it allowed in comparing measures of perceptual and cognitive ability with other traits of the subjects. The independent variables in this study were scores on the Children's Embedded Figures Tests (see Appendix D); scores on Cross-modal Sensory Transfer Tasks 1 (visual to visual matching), 2 (visual to tactile matching), and 3 (tactile to visual matching); scores on Cross-modal Sensory Transfer Combined Tasks (see Appendix C); gender of the subjects; and grade of the subjects. Gender of the subjects and grade of the subjects were the main effects tested in the multivariate analysis of variance (MANOVA). These variables were selected in order to determine whether a developmental trend existed in the data and/or whether there were gender-related differences in the data. (See Figure 3-1.)

Description of the Sample

The subjects were 60 children (55 white, 5 black) enrolled in the Lake Harbin Elementary School, Clayton County, Georgia, public

			Gender of Subject		
			Females	Males	
Grade of Subject	Kindergarten	CEFT $\overline{X}$ CMST $\overline{X}$	$\underline{n}$ = 15	$\underline{n}$ = 15	$\underline{n}$ = 30
	Fourth	CEFT $\overline{X}$ CMST $\overline{X}$	$\underline{n}$ = 15	$\underline{n}$ = 15	$\underline{n}$ = 30
			$\underline{n}$ = 30	$\underline{n}$ = 30	

CEFT = Children's Embedded Figures Test
CMST = Cross-modal sensory transfer combined score

$\underline{N}$ = 60
$\underline{nk}$ = 30 (F = 15, M = 15)
$\underline{n4}$ = 30 (F = 15, M = 15)

Figure 3-1. Design of the study.

school system. (See Appendix A.) Clayton County is a suburban county to the south of Atlanta, Georgia. The residents of the county are primarily lower middle class or working class. The primary source of employment within the county is locally owned small businesses. Many of the residents commute to Atlanta to work.

Four kindergarten classrooms and four fourth-grade classrooms were chosen as the population from which subjects could be selected. There was a total of 218 children enrolled in the eight classrooms. Thirty children (15 males, 15 females) from both the kindergarten and the fourth grade were selected as the sample. The sample was selected randomly from the 106 children who had parental permission to participate in the study, for a total sample of 60 children. The children were grouped by grade and sex before selection in order to insure equal numbers in each age/sex group.

All subjects in the study were enrolled in regular classrooms, and none were involved in remedial or special-education classes. As determined by test data, all children in the study were performing at grade level or above in their academic work. The tests given by the school to the children were the Metropolitan Readiness Test (kindergarten) and the Metropolitan Achievement Test (fourth grade).

Instrument Selection and Description

The Children's Embedded Figures Test (CEFT) (Karp & Konstadt, 1971) was used to obtain a field dependence/independence measure for each subject. The CEFT was administered and scored in accordance with standardized procedures outlined in the test manual. (See

Appendix D.) The CEFT is administered individually and consists of a series of 25 geometric drawings of familiar objects in which the child is to locate and trace around a specified geometric figure. (Only one exact matching figure is embedded in each of the 25 geometric drawings.) The CEFT is divided into two parts, tent (11 items) and house (14 items). The division is based on the stimulus figure that the child must locate in the drawings. The tent figure is an equilateral triangle colored red and black. The house figure is a combination of a rectangle and triangle and is blue. Scores for the test are the number of correct matches out of 25.

The CEFT was chosen because it is the most reliable standard measure of its type designed specifically for children in the 5-12 year age range. Internal consistency reliability coefficients for the CEFT range from .84 to .90 (Witkin et al., 1971). Correlations between the CEFT and the Embedded Figures Test, a similar measure for children over 12 and adults, yield validity coefficients of .71 at 9 years and .85 at 11 years (Witkin et al., 1971).

The Cross-modal Sensory Transfer Tasks consisted of three 10-item identification tasks. The objects used for stimuli in all three tasks were Milton Bradley geometric solids (ordering number MB-8064), a series of wooden figures averaging 3 inches in height. (See Appendix C.) Rational for selection of these figures as stimuli was threefold. First, the literature reveals that geometric figures are one of three types (geometric, biomorphic, alphabet) of stimuli used to test children's tactile-visual cross-modal sensory transfer ability (Pick, Pick, & Thomas, 1966; Walk, 1965). Second, the Milton

Bradley figures are widely available for use in replication of the study and are of convenient size and variety for use with children. A third reason for selection of the geometric figures as a stimuli set was that stimuli in the Children's Embedded Figures Test are also geometric. The relative consistency across measures of stimulus type helped to eliminate confounding that might have been added by a total nonequivalence of stimuli sets across measures, despite the fact that the CEFT involved use of plane geometric shapes and the cross-modal tasks used solid figures.

Task 1 of the Cross-modal Sensory Transfer Tasks was a visual-to-visual matching task (intramodal). This task served to bridge the gap between the visual matching tasks of the Children's Embedded Figures Test and the cross-modal matching of Tasks 2 and 3. In Task 1, the subject was asked to choose from among five geometric figures the object that matched a single standard figure. The standard and the choices were changed for each trial. (See Appendix C for details on administration and stimuli-set ordering.) Task 1 consisted of a practice trial followed by 10 scored trials. Each trial was scored 1 for a correct match and 0 for an incorrect response.

Task 2 of the Cross-modal Sensory Transfer Tasks was a visual-to-tactile matching task. In this task, the subject viewed the standard without being allowed to touch it and then was asked to find its match from an array of five geometric figures placed within a "feeling box" and out of the subject's sight. (See Appendix C.) Task 2 consisted of a practice trial followed by 10 scored trials.

Each trial was scored 1 for a correct match and 0 for an incorrect response.

Task 3 of the Cross-modal Sensory Transfer Tasks was a tactile-to-visual matching task. In this task, the subject was asked to feel the standard, which was presented inside the "feeling box" out of sight of the subject. The subject then visually chose a match for the standard from an array of five geometric figures placed on top of the "feeling box." (See Appendix C.) Task 3 consisted of a practice trial followed by 10 scored trials. Each trial was scored 1 for a correct match and 0 for an incorrect response.

The Combined Task Score was found by adding the scores of Tasks 1, 2, and 3. Each task had a maximum of 10 possible points and a minimum of 0 points. The maximum Combined Score was 30 points.

In Tasks 2 and 3, figures presented to the tactile mode for inspection were hidden from view of the subject by placing them within a "feeling box" of the type used in early childhood education settings to enhance tactile-discrimination skills. The box used measured 12" x 18" x 12" and had two 6-inch circular openings equipped with felt covers into which the subjects placed their hands. The back of the apparatus was open to the view of the researcher. Subjects were encouraged to use both hands to explore the figures presented for manipulation. The reasoning behind this was that two-handed exploration has been found to more closely resemble visual inspection of objects (Walk, 1965). Both tactile and visual stimuli were placed in a standardized order and position assigned to each trial of Tasks 1, 2, and 3. (See Appendix C for details related to the ordering of the stimuli.) None of the cross-modal tasks was timed. This procedure was adopted in order to match the nontimed procedures developed for the CEFT.

Procedure

The researcher assumed responsibility for administration of the Children's Embedded Figures Test and the Cross-modal Sensory Transfer Tasks. All testing sessions were held in the school library. Testing sessions were approximately 40 minutes in length. All subjects were given the Children's Embedded Figures Test first and then the Cross-modal Sensory Transfer Tasks 1, 2, and 3, in that order. It has been demonstrated that primary visual presentation enhances performance on visual and tactile cross-modal tasks (Jain & Sinha, 1978). Therefore, all children were given the stimuli in the same order and Task 1, Task 2, and Task 3 in the same order so as to minimize order effects. All testing followed the procedures described in the instruments section of this chapter and in Appendices C and D. Every attempt was made to provide a standard testing situation across subjects.

The testing period lasted 2 weeks. The kindergarten children were tested the first week, and the fourth graders were tested the second week. Fridays of both weeks were scheduled as make-up days for subjects who missed their assigned test periods on Monday through Thursday.

Ethical Considerations

All children participating in the study had a signed letter of informed consent on file with the researcher. (See Appendix B for letter.) No child was forced to participate in a testing situation against his/her own will, nor was any attempt made to coerce any child to participate. All 60 of the children in the original sample participated willingly in the study and were present on their assigned testing date. Scheduling of testing dates was made with the cooperation of the classroom teacher to insure that no child missed important course work or was deprived of a favorite activity. The researcher escorted the kindergarten children to and from the testing site and waited at the door of the testing room for the fourth graders, who walked from their classrooms. Every attempt was made to insure that a minimum amount of class time was missed by each subject.

All data were collected and stored using a four-digit code number (selection number, grade, and sex). (See Appendix E.) Children's names were not used in reporting the study. Parents of the subjects received a copy of the child's scores at the completion of the data-collection period. A written summary of results was made available to school staff and to parents upon completion of the project.

Data Analysis

The data were analyzed using a series of Pearson's correlations and a 2 x 2 multivariate analysis of variance (MANOVA). Level of significance was set at .05. The Statistical Package for the Social Sciences (SPSS) Version 8 was the statistical package used for the analysis. The Michigan State University Computer Center provided assistance in the analysis. (See Appendix F.)

Summary

This study used a series of correlational designs and a 2 x 2 factorial design to test relationships between two measures of perceptual and cognitive abilities in kindergarteners and fourth graders. Instruments used to measure perceptual and cognitive abilities were the Children's Embedded Figures Test and Cross-Modal Sensory Transfer Tasks 1, 2, and 3. Sixty subjects, 30 each in kindergarten (males = 15, females = 15) and fourth grade (males = 15, females = 15), participated in the study. Independent variables were scores on the Children's Embedded Figures Test and the three Cross-modal Sensory Transfer Tasks, and a combined score of all three Cross-modal Sensory Transfer Tasks, grade of subjects, and gender of subjects.

CHAPTER IV

ANALYSIS OF RESULTS

Data for this study were analyzed using Pearson's correlations for those comparisons involving only two variables and a multivariate analysis of variance (MANOVA) for comparison of Children's Embedded Figures Test scores means and Cross-modal Sensory Transfer Tasks combined scores means both across and within age/gender groups. A level of .05 was chosen as the lowest possible level of significance acceptable in this study.

Correlation is the statistic of choice when there is "no clear-cut distinction between two kinds of scores as to which is the independent or predictor variable" (Hays, 1973, p. 619), which was the case in comparing the variables in this study. A correlation procedure was selected for analysis of pairs of variables in this study because this type of statistic not only allows for measurement of the directionality and strength of a relationship between two variables but also provides a basis for establishing a means of predicting the direction of a second variable when the direction of the first variable is known (Hays, 1973). The statistical procedure yielding the Pearson product-moment correlation coefficient was chosen because the process results in correlation coefficients that are independent of both the means of the scores tested and of the standard deviations of groups of scores (Glass & Stanley, 1970). This allows for correlation coefficients to be converted to $\underline{Z}$ scores and a level of significance to be found for the relationships.

The multivariate analysis of variance (MANOVA) is used to test main effects in analysis involving more than one variable per cell. The MANOVA procedure also allows for the testing for interaction between main effects, which in this study were grade and gender of subject. Interaction between main effects precludes any further analysis (Hays, 1973). The MANOVA procedure contains univariate analyses within it so that effects of single main effects may also be tested.

Analysis of data for this study involved comparison of scores for Cross-modal Sensory Transfer Tasks 1, 2, 3, and Combined Scores with scores for the Children's Embedded Figures Test for boys and girls in kindergarten and fourth grade. The analysis was structured so that (a) relationships among the Cross-modal Sensory Transfer Tasks could be determined, (b) relationships between the Cross-modal Sensory Transfer Tasks and the Children's Embedded Figures Test could be determined, and (c) effects of grade of subject and/or gender of subject on the relationship between the Cross-modal Sensory Transfer Tasks and the Children's Embedded Figures Test could be determined. The means and standard deviations used for the analyses presented later in this chapter appear in Table 4-1.

Table 4-1. Means, Ranges, Variances, and Standard Deviations for Cross-modal Sensory Transfer Tasks 1, 2, 3, and Combined Scores and Children's Embedded Figures Tests (N = 60)

	$\bar{X}$	Maximum Range	Sample Range	Variance	SD
Combined Score[a]	26.33	0-30	16-30	8.53	2.92
Task 1[a]	9.93	0-10	8-10	.09	.31
Task 2[a]	8.28	0-10	4-10	2.31	1.52
Task 3[a]	8.18	0-10	3-10	2.17	1.47
CEFT[b]	10.81	0-25	1-23	44.42	6.67

[a]Cross-modal Sensory Transfer Task.

[b]Children's Embedded Figures Test.

Hypothesis 1

Null Hypothesis: Scores for Cross-modal Sensory Transfer Task 1 (visual-to-visual matching) are not related to scores for Cross-modal Sensory Transfer Task 2 (visual-to-tactile matching).

Alternative Hypothesis: Scores for Cross-modal Sensory Transfer Task 1 (visual-to-visual matching) are positively related to scores for Cross-modal Sensory Transfer Task 2 (visual-to-tactile matching).

Comparisons between Task 1 and Task 2 were analyzed using Pearson correlations and were based on the following groupings: total group scores (N = 60), kindergarteners (n = 30), fourth graders (n = 30), females (n = 30), and males (n = 30). Results were significant for total group, kindergarteners, and females at α .05. Results were nonsignificant for males. (See Table 4-2.)

Table 4-2. Pearson Correlation Coefficients for Comparison of Task 1 With Task 2

Variable	Correlation Coefficient	Level of Significance
Total group	*r* = .43	*p* = .001*
Kindergarteners	*r* = .49	*p* = .002*
Fourth graders	uncomputable[a]	..
Females	*r* = .52	*p* = .002*
Males	*r* = .24	*p* = .096

[a]No variation in Cross-modal Sensory Transfer Task 1 scores.

*Significance level set at .05.

Hypothesis 2

Null Hypothesis: Scores for Cross-modal Sensory Transfer Task 1 (visual-to-visual matching) are not related to scores for Cross-modal Sensory Transfer Task 3 (tactile-to-visual matching).

Alternative Hypothesis: Scores for Cross-modal Sensory Transfer Task 1 (visual-to-visual matching) are positively related to scores for Cross-modal Sensory Transfer Task 3 (tactile-to-visual matching).

Comparisons between Task 1 and Task 3 were analyzed using Pearson correlations and were based on the following groupings: total group scores (N = 60), kindergarteners (n = 30), fourth graders (n = 30), females (n = 30), and males (n = 30). Results were significant for total group, kindergarteners, females, and males at α = .05. (See Table 4-3.)

Table 4-3. Pearson Correlation Coefficients for Comparison of Task 1 With Task 3

Variable	Correlation Coefficient	Level of Significance
Total group	r = .49	p = .001*
Kindergarteners	r = .56	p = .001*
Fourth graders	uncomputable[a]	..
Females	r = .56	p = .001*
Males	r = .34	p = .034*

[a]No variation in Cross-modal Sensory Transfer Task 1 scores.

*Significance level set at .05.

Hypothesis 3

Null Hypothesis: Scores for Cross-modal Sensory Transfer Task 2 (visual-to-tactile matching) are not related to scores for Cross-modal Sensory Transfer Task 3 (tactile-to-visual matching).

Alternative Hypothesis: Scores for Cross-modal Sensory Transfer Task 2 (visual-to-tactile matching) are positively related to scores for Cross-modal Sensory Transfer Task 3 (tactile-to-visual matching).

Comparisons between Task 2 and Task 3 were analyzed using Pearson correlations and were based on the following groupings: total group scores (N = 60), kindergarteners (n = 30), fourth graders (n = 30), females (n = 30), and males (n = 30). Results were significant for all comparison groups at α = .05. (See Table 4-4.)

Table 4-4. Pearson Correlation Coefficients for Comparison of Task 2 With Task 3

Variable	Correlation Coefficient	Level of Significance
Total group	$r = .69$	$p = .001$*
Kindergarteners	$r = .69$	$p = .001$*
Fourth graders	$r = .55$	$p = .001$*
Females	$r = .65$	$p = .001$*
Males	$r = .75$	$p = .001$*

*Significance level set at .05.

Hypothesis 4

Null Hypothesis: Scores for the Children's Embedded Figures Test are not related to:

a. Cross-modal Sensory Transfer Task 1 (visual-to-visual matching)
b. Cross-modal Sensory Transfer Task 2 (visual-to-tactile matching)
c. Cross-modal Sensory Transfer Task 3 (tactile-to-visual matching)
d. Cross-modal Sensory Transfer Combined Tasks scores

Alternative Hypothesis: Scores for the Children's Embedded Figures Tests are positively related to:

a. Cross-modal Sensory Transfer Task 1 (visual-to-visual matching)
b. Cross-modal Sensory Transfer Task 2 (visual-to-tactile matching)
c. Cross-modal Sensory Transfer Task 3 (tactile-to-visual matching)
d. Cross-modal Sensory Transfer Combined Tasks scores

For Hypothesis 4a, comparisons between CEFT and Tasks 1, 2, 3, and Combined Scores were analyzed using Pearson correlations and were based on the following score groupings: total group ($N = 60$), kindergarteners ($n = 30$), fourth graders ($n = 30$), females ($n = 30$), and males ($n = 30$). Results were significant for total group and kindergarten at α .05. Results were nonsignificant for males and for females. (See Table 4-5.)

Table 4-5. Pearson Correlation Coefficients for Comparison of Cross-modal Sensory Transfer Tasks 1, 2, 3, and Combined Scores With Children's Embedded Figures Test

Variable	Correlation Coefficient	Level of Significance
Total Group		
Task 1	r = .28	p = .015*
Task 2	r = .71	p = .001*
Task 3	r = .61	p = .001*
Combined Scores	r = .70	p = .001*
Kindergarteners		
Task 1	r = .69	p = .014*
Task 2	r = .66	p = .001*
Task 3	r = .51	p = .002*
Combined Scores	r = .63	p = .001*
Fourth Graders		
Task 1	uncomputable[a]	..
Task 2	r = .85	p = .001*
Task 3	r = .73	p = .001*
Combined Scores	r = .90	p = .001*
Females		
Task 1	r = .29	p = .054
Task 2	r = .62	p = .001*
Task 3	r = .49	p = .003*
Combined Scores	r = .59	p = .001*
Males		
Task 1	r = .25	p = .088
Task 2	r = .81	p = .001*
Task 3	r = .75	p = .001*
Combined Scores	r = .83	p = .001*

[a]No variation in Cross-modal Sensory Transfer Task 1 scores.

*Significance level set at .05.

For Hypothesis 4b, comparisons between measures were analyzed using Pearson's correlations and were based on the following score groupings: total group (N = 60), kindergarteners (n = 30), fourth graders (n = 30), females (n = 30), and males (n = 30). Results were significant for all score groupings. (See Table 4-5.)

For Hypothesis 4c, comparisons between measures were analyzed using Pearson correlations and were based on the following score groupings: total group (N = 60), kindergarteners (n = 30), fourth graders (n = 30), females (n = 30), and males (n = 30). Results were significant for all score groupings. (See Table 4-5.)

For Hypothesis 4d, comparisons between measures were analyzed using Pearson correlations and were based on the following score groupings: total group (N = 60), kindergarteners (n = 30), fourth graders (n = 30), females (n = 30), and males (n = 30). Results were significant for all score groupings. (See Table 4-5.)

Multivariate Analysis of Variance for Hypotheses 5 and 6

A multivariate analysis of variance (MANOVA) procedure was used to test the combined main effects of grade of subject and gender of subject on the scores of Children's Embedded Figures Tests and Cross-modal Sensory Transfer Tasks Combined Scores. Both the multivariate analysis of variance and the subsequent analyses of variance (ANOVA) yielded no significant interaction effect between the two main effects. (See Table 4-6.) As there was no significant interaction found between the two main effects, analysis of each main effect could be carried out to determine the individual effect of each main effect on the scores of the two measures. Had a significant interaction been found, analysis would have been terminated at this point, and it would have been impossible to test Hypotheses 5 and 6.

Table 4-6. Multivariate and Univariate Analyses of Grade and Gender of Subject for Children's Embedded Figures Tests Scores and Cross-modal Sensory Transfer Tasks Combined Scores

Variable	df	SS	F	p<
Multivariate Analysis				
Gender & grade	2,55		.03	.43
Univariate Analyses				
CMST[a]	1,56	1.66667	.24	.63
CEFT[b]	1,56	6.01667	.35	.56

[a]Cross-modal Sensory Transfer Tasks Combined Scores.

[b]Children's Embedded Figures Test scores.

Hypothesis 5

Null Hypothesis: Fourth graders, as a group, will perform no better than kindergarteners on:
a. Cross-modal Sensory Transfer Tasks Combined Scores
b. Children's Embedded Figures Test scores

Alternative Hypothesis: Fourth graders, as a group, will perform better than kindergarteners on:
a. Cross-modal Sensory Transfer Tasks Combined Scores
b. Children's Embedded Figures Tests scores

Comparisons for Cross-modal Sensory Transfer Tasks Combined Scores and Children's Embedded Figures Tests scores were analyzed using a multivariate analysis of variance (MANOVA) and several univariate analyses of variance (ANOVA) procedures. Results of the analysis indicate that for a combined analysis of both measures (CEFT and Cross-modal Tasks) grade is significant as a main effect (F = .66133, p = .00001). Univariate analyses yielded the following results: For Children's Embedded Figures Tests, grade was a significant main effect (F = 92.67429, p = .00001); for Cross-modal Sensory Transfer Tasks Combined Scores, grade was a significant main effect (F = 11.62712, p = .00121). (See Table 4-7.)

Table 4-7. Multivariate and Univariate Analyses of Grade of Subject for Children's Embedded Figures Test and Cross-modal Sensory Transfer Tasks Combined Scores

Variable	df	SS	F	p<
Grade	Multivariate Analysis			
Grade	2,55		.66	.001*
	Univariate Analyses			
CMST[a]	1,56	81.66667	11.63	.001*
CEFT[b]	1,56	1591.35	92.67	.001*

[a]Cross-modal Sensory Transfer Tasks Combined Scores.

[b]Children's Embedded Figures Tests scores.

*Significance level set at .05.

Hypothesis 6

Null Hypothesis: Males, as a group, will perform no better than females on:

a. Cross-modal Sensory Transfer Tasks Combined Scores
b. Children's Embedded Figures Tests scores

Alternate Hypothesis: Males, as a group, will perform better than females on:

a. Cross-modal Sensory Transfer Tasks Combined Scores
b. Children's Embedded Figures Tests scores

Comparisons for Cross-modal Sensory Transfer Tasks Combined Scores and Children's Embedded Figures Test scores were analyzed using a multivariate analysis of variance (MANOVA) and several univariate analyses of variance (ANOVA) procedures. Results of the analysis indicate that for a combined analysis of both measures (CEFT and cross-modal tasks) gender is not significant as a main effect (F = .07347, p = .12264). Univariate analyses yielded the following results: For Children's Embedded Figures Tests, gender was not a significant main effect (F = 3.66162, p = .06253); for Cross-modal Sensory Transfer Tasks Combined Scores, gender was not a significant main effect (F = 3.77661, p = .05637). (See Table 4-8.)

Table 4-8.--Multivariate and Univariate Analyses of Gender of Subject for Children's Embedded Figures Test and Cross-modal Sensory Transfer Tasks Combined Scores

Variable	df	SS	F	p<
Multivariate Analysis				
Gender	2,56		.07	.122
Univariate Analyses				
CMST[a]	1,56	26.66667	3.79	.056
CEFT[b]	1,56	62.01667	3.66	.063

[a]Cross-modal Sensory Transfer Tasks Combined Scores.

[b]Children's Embedded Figures Tests scores.

Discussion of Results

Analyses associated with Hypotheses 1, 2, and 3 (see Tables 4-2, 4-3, and 4-4) indicated that all three of the Cross-modal Sensory Transfer Tasks were significantly and positively related to one another. The results also showed that the two cross-modal tasks (Task 2--visual-to-tactile matching and Task 3--tactile-to-visual matching) were more closely related to each other than they were to the intramodal task (Task 1--visual-to-visual matching). Although the Cross-model Sensory Transfer Tasks were based on a standard experimental procedure, they were not a standardized measure. Therefore, it was important to determine if the three tasks were positively related in order to collapse the scores of the three tasks into the Cross-modal Sensory Transfer Tasks Combined Scores used to compare cross-modal ability with a measure of field dependence/independence, the Children's Embedded Figures Test.

Comparison of field dependence/independence with cross-modal ability was accomplished through the correlation of scores on the Children's Embedded Figures Test with scores for Cross-modal Sensory Transfer Tasks 1, 2, and 3, and Combined Scores (see Table 4-5). As it was not known before analysis of the data that Tasks 1, 2, and 3 were positively related, it was necessary to structure this part of the analysis to include both the subtests (Tasks 1, 2, and 3) and the collapsed scores (Combined Scores) of cross-modal ability. The results of these analyses indicate that scores for Tasks 1, 2, and 3 and Combined Scores are all positively and significantly related to scores on the Children's Embedded Figures Test for subjects in this study. These results indicate that at least for behaviors measured by the Children's Embedded Figures Test and the Cross-modal Sensory Transfer Tasks, field dependence/independence and cross-modal transfer ability are related abilities.

To determine gender effects and grade-level effects on the scores of the two measures used in this study (Children's Embedded Figures Test and Cross-modal Sensory Transfer Tasks), a series of multivariate analyses of variance (MANOVA) and subsequent analyses of variance (ANOVA) were used to analyze the data. It was determined that for this sample there was no interaction between the main effects of gender of subject and grade level of subject. Therefore, the effects of the variables grade and gender could be determined individually. (See Tables 4-6, 4-7, and 4-8.) The main effect of grade level of subject was highly significant for both measures combined (p = .00001) and for each measure individually (CEFT: p = .00001; CMST: p = .00121). These findings are consistent with the hypothesized developmental trend and with findings of other studies of measures of field dependence/independence and cross-modal transfer ability (Derevensky, 1977).

The main effect of gender of subject was not significant for either both measures combined (p = .12264) or for each measure individually (CEFT: p = .06253; CMST: p = .05637). These findings are also consistent with reports of other studies of field dependence/independence and cross-modal transfer ability children (Maccoby et al., 1965).

In summary, the analysis of data revealed that Cross-modal Sensory Transfer Tasks 1, 2, and 3 were all significantly and positively related to each other. Cross-modal Sensory Transfer Tasks 1, 2, 3, and Combined Scores were significantly and positively related to scores on the Children's Embedded Figures Test (CEFT). There was no interaction effect between gender of subject and grade of subject in the comparison of Cross-modal Sensory Transfer Tasks Combined Scores and Children's Embedded Figures Tests scores. Grade of subject was significantly and positively related to scores on both measures, whereas gender of subject was not.

CHAPTER V

CONCLUSIONS, IMPLICATIONS, AND SUMMARY

Review of the Problem

In this study, the researcher was concerned with the nature of the relationship between field dependence/independence as measured by the Children's Embedded Figures Test (CEFT) and cross-modal transfer ability as measured by Cross-modal Sensory Transfer Tasks 1, 2, 3, and Combined Scores. Subjects in the study were 30 kindergarteners (15 girls, 15 boys) and 30 fourth graders (15 girls, 15 boys). The children's scores on both measures were compared and the effects of grade and gender of the subject were determined. Data analysis revealed that there was a positive and significant relationship between the CEFT and Cross-modal Sensory Transfer Tasks 1, 2, 3, and Combined Scores. (See Tables 4-2, 4-3, 4-4, 4-5.) There was a significant main effect for grade (see Table 4-7) but not for gender of subject (see Table 4-8), indicating that for both measures there were age-related differences but no gender-related differences.

The purpose for comparing a measure of field dependence/independence with a measure of cross-modal transfer was to help establish empirically that both abilities are manifestations of an underlying perceptual and cognitive function, the ability to isolate and use essential features of an object. Ability to isolate essential features has been related to numerous cognitive and personality traits and has been shown to affect family functioning, group functioning, and career choice. An understanding of the interrelationships of measures of ability to isolate essential features and the process of development of the ability has implications for the study of the individual, the family, and the structure and function of various social groups such as the classroom.

Conclusions

Results of this study seem to support ideas concerning the interrelationships of those abilities associated with field dependence/independence and cross-modal sensory transfer found in the literature. A developmental trend throughout childhood has been noted in research dealing with both constructs (Derevensky, 1977; Witkin, Goodenough, & Karp, 1967). In this study, both girls and boys in the fourth grade exhibited more accuracy on both measures (Cross-modal Sensory Transfer Tasks 1, 2, 3, and Combined Scores and Children's Embedded Figures Tests) than did the kindergarteners.

Although the question of causality has not been resolved in the literature, it is firmly established that gender differences in performance in cross-modal transfer ability and field independence found in adults' scores are not a factor in children under 12 years of age (Vaught, 1965). Results of this study add to the growing body of literature that describes abilities of boys and girls on perceptual/spatial tasks as equivalent in the childhood years. However, it should be noted that while gender differences noted in this study were not significant, they were present and several were close to the established level for significance (see Table 4-8). Apparently, differences in spatial ability between boys and girls that reach a level of significance by adolescence are present in younger children to some extent.

Many researchers have noted that presentation of stimuli to the visual mode increases performance levels in visual/tactile cross-modal tasks and that visual-to-visual tasks result in higher performance levels than do cross-modal tasks (Fishbein, Decker, & Wilcox, 1977). All scores on Cross-modal Tasks 1, 2, and 3 correspond with the above findings. All the children performed better on Task 1 (visual-to-visual matching) than on Task 2 (visual-to-tactile matching) or on Task 3 (tactile-to-visual matching). Performance was better on Task 2 than on Task 3. Although total group scores for Task 1 correlated significantly with scores for both Tasks 2 and 3, the correlation for Task 2 with Task 3 was substantially higher. (See Tables 4-2, 4-3, and 4-4.) This finding seems to follow the logic that cross-modal tasks by the nature of their use of two modalities are more similar to each other than a cross-modal task would be to an intramodal or single-mode task (Walk & Pick, 1981).

It should be noted, however, that for boys, the correlation between Task 1 and Task 2 was low and nonsignificant ($\underline{r} = .25$, $\underline{p} = .096$) and for Task 1 with Task 3 was low and barely within the acceptable level of significance ($\underline{r} = .37$, $\underline{p} = .034$). This was due to less variation in Task 1 scores for boys and might be an area for further research into the nature of gender differences in spatial abilities that appear in adolescents and adults. Another finding of note along these same lines is that Task 1 was significantly correlated to the Children's Embedded Figures Test (see Table 4-5) only for kindergarten and total group scores. The total group score correlation seemed to be biased by the kindergarten scores. It was impossible to calculate correlation coefficients for the fourth grade due to no variation in Task 1 scores. It seems that by fourth grade, intramodal ability is firmly established and that cross-modal ability is a much better indicator of an individual child's ability to disembed.

Other researchers have established that field dependence/independence and cross-modal transfer ability are related to scores on performance subtests of the WISC and to socioeconomic status (Derevensky, 1977; Ghuman, 1977). As noted earlier, children in this study sample were from primarily lower-middle and working-class families. The children in the sample were all of average to above-average intellectual ability as evidenced by school achievement test scores and placement in normal classrooms. The mean scores on the Children's Embedded Figures Test for this study sample were similar for all gender/grade groups (except kindergarten boys) to the norms presented in the test manual (Witkin et al., 1971). (See Table 5-1.) The difference between the sample kindergarten boys and the norming-data kindergarten boys can be attributed to two extremely high scores (15 and 19 out of a possible 25) on the Children's Embedded Figures Test by two kindergarten boys in the sample.

Table 5-1. Sample Means and Norming-Data Means for Children's Embedded Figures Test

Subject	Norming-Data Means	Sample Means
Kindergarten girls	4.2	4.23
Kindergarten boys	3.8	6.33
Fourth-grade girls	16.3	15.26
Fourth-grade boys	16.6	16.66

As noted above, the research findings from this study are supported by other literature concerned with the development of cross-modal sensory transfer ability and field dependence/independence. Results of this study seem to fall within the expected range of possibilities established over the past 30 years for field dependence/independence and cross-modal sensory transfer ability in kindergarteners and fourth graders. This study has helped to demonstrate that cognitive and perceptual abilities associated with ability to disembed in children are interrelated and developmental in nature.

Personal Observations

As this study was conducted in the library of an elementary school, there were numerous opportunities to observe interactions of children with the test materials outside of actual data collection. Approximately 20 children in Grades 5 and 6 served as library aides. These children helped the librarian for a 1-hour period several times during the week. Most of these children were enrolled in the school's gifted program. After watching the testing for several days, the library aides asked to try the cross-modal tasks. All these children received perfect scores on all three tasks. The researcher then modified the two cross-modal tasks (Tasks 2 and 3) so that orientation of stimulus figure did not match orientation of matching figure (e.g., rectangular prism on end versus rectangular prism on side). This addition of a mental-rotation component to the tasks seemed to increase difficulty, and scores dropped to approximately 7 correct responses out of 10.

There has been some speculation that verbal mediation plays a role in cross-modal transfer (Piaget, 1969). The researcher observed that for this sample, verbal mediation, at least knowledge of names of geometric solids, did not seem to be necessary for cross-modal transfer. Almost all the kindergarteners and many of the fourth graders asked to examine both sets of the geometric solids used as stimuli for the cross-modal tasks. While the children played with the solids, the researcher asked each child to name the solids. Very few children could name the solids, although several children in both grades called the solids by the name of the proper corresponding plane figure. For example, children were presented spheres and called them circles. A few other children named the solids after objects in the environment. For example, children were presented circles and called them balls. Apparently, some of the children had a labelling scheme, but not for all the solids in the stimuli sets.

The researcher also had an opportunity to talk informally on several occasions with teachers in the school. During one of these discussions it was learned that the fathers of both of the kindergarten boys whose scores were unusually high on the Children's

Embedded Figures Test were commercial airline pilots. This information is most interesting in light of the research indicating high levels of field independence in airline pilots (Cullen et al., 1969). This might suggest a possible genetic and/or family-training component in the development of ability to disembed. This researchable question needs further study.

Limitations of the Study

Generalizability

Conclusions based on the results of this study are limited in their ability to apply to the general population. The sample was fairly homogeneous, and assignment procedures were not totally random. (See Chapter II, Subjects.) A wide range of geographic areas, socioeconomic groups, and racial/ethnic groups was not included in the sample, so results cannot be generalized beyond southern, suburban white children.

Instruments

Cross-modal Sensory Transfer Tasks 1, 2, and 3 were too simple and did not allow for enough sample variation in scores, particularly at the fourth-grade level. All fourth-grade children made perfect scores on Task 1 (visual-to-visual matching). It is suggested that only cross-modal measures be used in future studies or that separate hypotheses be developed for the testing of intramodal tasks. It is also suggested that stimuli with more subtle variation such as irregular or combination geometric solids be used in subsequent studies.

Additional Data on Subjects

Actual measures of intelligence were not given to the subjects in this study because of resistance to this idea by school officials. These data would have been helpful in explaining some of the variance from the norm of scores on the Children's Embedded Figures Tests and in establishing the actual mean level of intelligence of the groups tested in order to determine how closely the sample groups matched groups from other studies. Actual income and educational level of the family of each child in the study was not available because of concern by the school board for family confidentiality. This information would also have been helpful in explaining differences in the study sample and in relating data from this study to data in other studies. It is suggested that this information be collected if the study is replicated.

Assessment of Developmental Trend

Only two grade levels were used in this study. It can be demonstrated that there was an age-related change between the groups, but developmental change beyond that cannot be inferred. It is suggested that several grades, possibly kindergarten, second, fourth, and sixth, be tested in order to understand more fully the nature of the development of ability in cross-modal transfer and in field independence.

Implications of the Study

Numerous theorists have postulated linkages between perceptual and cognitive abilities (Piaget, 1969; Witkin & Goodenough, 1981).

This study demonstrated that there was, indeed, a positive relationship between field dependence/independence and cross-modal sensory transfer ability in elementary-school-aged children and that the relationship was stronger for the older children. This type of research adds to the empirical base supporting cognitive and perceptual theories of Witkin, Gibson, and Piaget. If field dependence/independence and cross-modal sensory transfer ability do tap the underlying cognitive and perceptual ability to isolate essential features of objects, then knowledge of the relationship between the measures can be used as a tool for further exploration of how humans come to know objects in their environment and how behavior is affected by perceptual and cognitive style.

Other research on field dependence/independence and cross-modal sensory transfer ability has demonstrated a relationship of these traits to intelligence (Ghuman, 1977), creativity (Damusis & Desjarlais, 1977), age (Gibson, 1967), and ability of parent in similar tasks (Schaffer, 1969). The interrelationship of the two traits investigated in this study and their relationships to other cognitive and perceptual traits point quite sharply to the systemic nature of cognitive and perceptual processes in human beings. Further study of the relationships between aspects of the cognitive and perceptual process will, no doubt, add to the body of knowledge concerned with how humans relate to their environments and how they use information from their environments to make decisions.

The results of this study are particularly applicable to the development of screening materials for special education. Batteries of tests for assessing cognitive and perceptual performance have been developed by special educators to help determine nature and direction of perceptual problems in children with reading difficulties and learning disabilities (Temple, Williams, & Bateman, 1979). Knowledge of the interrelationships between cognitive and perceptual abilities and their related measures will help to reduce the number of tests needed for general testing by providing information about which tests will yield the same or similar information and can, therefore, be combined or eliminated. It will also increase the number of associated measures for testing for a specific disability. This will lead to less stress in testing situations for both the child and the examiner and more accurate assessment of the child.

General knowledge of organization of cognitive and perceptual learning schemes is of utmost importance in the continual development of appropriate educational materials and methods for all children. It has been noted that cross-modal transfer ability is strongly related to reading skill in children beyond second grade (Derevensky, 1977) and that the Children's Embedded Figures Test relates to performance subtests on the WISC (Damusis & Desjarlais, 1977). The visual/spatial component found in both field independence and cross-modal transfer ability seems to be an essential factor in creativity and independence in children, and it has been shown that training in these areas can increase performance in visual/spatial abilities, especially for girls (Butler, 1979). Knowledge that tasks involving cross-modal transfer ability are related to field independence can help educators in training efforts in visual/spatial skills and may aid in the development of tasks and methods that can help to increase both reading skills and visual/spatial skills in children. More information about the assessment of ability to disembed would be helpful in identification of children who show talent in art and music (Witkin, Moore, Goodenough, & Cox, 1977).

It has been demonstrated that field dependence/independence is related to numerous aspects of child-rearing practice and family functioning (Witkin & Goodenough, 1981). The understanding of the ability to use perceptual information to solve problems and how it develops in individuals and within a family context has widespread implications for study of the family and of child rearing. Knowledge of how perceptual information is transferred and how that process is taught within the family could be used to enhance the study of decision making in families. A particular emphasis in this area might be parent-child relationships and the interaction of inherited perceptual ability with learned behavior. Communication patterns within the family also depend on perception of information, and this, in turn, has bearing on personality and role development of family members. Studies such as the one reported in this paper help to provide information about the linkages between perceptual abilities and lay the groundwork for an understanding of the interplay among numerous abilities that comprise an individual's cognitive and perceptual style and how that style affects interactions with other human beings.

Suggestions for Future Research

An initial suggestion would be to repeat this study correcting, as far as possible, those problems listed as limitations to the study, i.e., obtain a more heterogeneous sample; obtain information about subjects, such as intelligence test scores and socioeconomic status of subjects' families; select more challenging geometric solids for stimuli sets in cross-modal tasks; test several grades rather than two; and separate cross-modal from intramodal tasks for data analysis. It might also be interesting to determine the relationship of other figure-ground tests to the Children's Embedded Figures Test and Cross-modal Sensory Transfer Tasks to determine how strong the relationship among tests might be. The CEFT has been related to a number of diverse human functions; however, cross-modal transfer ability has been studied primarily in relation to school learning. Given that CEFT has been shown to relate to cross-modal ability in school-age children, it would be useful to know if and how cross-modal transfer ability is related to personality development, family functioning, and child-rearing practices. Evidence such as this would further solidify the linkage between field independence and cross-modal transfer ability.

Summary

This study demonstrated that for children in kindergarten and fourth grade, there was a positive and significant relationship between measures of field dependence/independence and cross-modal transfer. This relationship showed grade-related patterns of improvement, and there was no significant difference between performances of boys and girls.

The results of this study and others like it have both theoretical and practical implications. In the realm of theory, this study has added to the empirical support for a hypothesized cognitive and perceptual system that governs intellectual and family functioning. The results of this study can also be used to help create both special- and general-education materials and teaching methods for areas such as reading and visual/spatial tasks. The study of interactions of individuals within a family can also be enhanced through continual discovery of the relationships of perceptual and cognitive functions that affect human social behavior.

APPENDICES

APPENDIX A

INFORMATION TO CLAYTON COUNTY SCHOOL BOARD

MICHIGAN STATE UNIVERSITY

COLLEGE OF HUMAN ECOLOGY
DEPARTMENT OF FAMILY AND CHILD ECOLOGY

EAST LANSING · MICHIGAN · 48824

431 Abbott Road, Apt. 3
East Lansing, Michigan 48823

February 19, 1982

Mr. Emmett Lee
Assistant Superintendent of Schools
Board of Education-Clayton County
Jonesboro, Georgia 30236

Dear Mr. Lee:

In response to our telephone conversation of February 17, I am sending you the enclosed information concerning the research project I am proposing for kindergarteners and fourth graders at Lake Harbin Elementary School. This research is being proposed as part of the requirements for my Ph.D. in Child Development from Michigan State University. A full proposal will be sent separately.

Should you decide to allow me to conduct this research project at Lake Harbin Elementary School, the weeks of March 15-19 and March 22-26 would be my first choice of times to gather the data. Of course, I am very willing to work around a schedule that is convenient for you and for the school personnel.

I can be reached at the above address or at (517) 332-3337 if you have any questions. My dissertation director, Dr. Lillian Phenice, can be reached at (517) 353-5248. Thank you for your consideration.

Sincerely,

Margaret E. Griffin

Proposal Abstract

This research project is being conducted to determine the relationship between field dependence/independence and visual/tactile cross-modal sensory transfer. In practical terms, what we are looking for are links in children's abilities to determine essential features of objects and to use those features to make decisions about similar objects. Much research has been conducted on children's abilities in field dependence/independence tasks and in cross-modal sensory transfer. However, very few studies have been conducted on wide-scale ability to determine essential features. We believe that the mechanism underlying both abilities is the same and hope to gain evidence to bolster this idea through this research.

The procedure for testing the two abilities is relatively simple. The measure for field dependence/independence is a standardized test called Children's Embedded Figures Test (CEFT). The test was developed by Karp and Konstadt and is published by Consulting Psychologists Press, Inc. The CEFT is administered individually and consists of a series of pictures in which the child is to locate a specified geometric figure. There is no standardized test of cross-modal transfer ability; however, there is a standard methodology for measurement of skill in that area. The methodology calls for the child to select from an array of figures a standard geometric stimulus. If the stimulus is presented visually, the child will select its match tactilely and vice-versa. The object is to match what the child sees with what he/she touches. The cross-modal transfer tasks are also administered individually. Total testing time for each child is estimated at 30 minutes. The researcher, Margaret Griffin, will take responsibility for all testing.

This proposal has been submitted to all appropriate college and university committees.

Subjects Needed

30 Kindergarteners--15 males, 15 females
30 4th graders --15 males, 15 females

I will need cooperation of the school in the following:

1. Distribution and collection of informed consent forms.
2. A room at the school in which to conduct testing sessions.

I will provide the following to the school:

1. Informed consent forms for each child's parent(s).
2. Orientation meetings for parents, teachers, and children.
3. Proper supervision of children to, from, and during the testing sessions.
4. A report of the results of the study.
5. Library materials appropriate for kindergarten and fourth grade (to be selected by school personnel).

Ethical Considerations

All children participating in this study will have a signed letter of informed consent on file with the researcher. No child will be asked to participate in a testing session against his/her own will, nor will any attempt be made to coerce the child to participate. Should any child show signs of distress during any session, the session will be terminated and the child returned to home room. Every effort will be made to cooperate fully with teachers in order to minimize any disruptive effect that removal of children from the classroom might have. It will be the responsibility of the researcher to escort each child to and from the testing site. It is not expected that participation in this study will be either harmful or beneficial to children in any way.

All data will be collected, stored, and reported using a four-digit code number (grade, sex, selection number) to identify the individual child. No names of children will be recorded in any phase of the study.

APPENDIX B

INFORMATION SENT TO SUBJECTS' PARENTS

Letter of Personal Information

Dear Parents:

My name is Margaret (Meg) Griffin. I am a graduate student at Michigan State University in the field of Child Development. I have lived in Michigan for 3-1/2 years now, but I am originally from Tennessee. I have been a teacher for four years and am presently working part-time for Michigan 4-H while completing my degree. I learned about your school district through my sister, Patty Griffin, who is a physical education teacher at Lake Harbin Elementary School.

My major research interest is centered around how the way people see affects the way they think. The research that I plan to conduct at your child's school fits into this type of research plan. In particular, your child if he or she participates in the study will be helping me to find out if children can look at a simple geometric figure and then locate that figure in a picture or by feeling for it inside a box. Collection of this type of simple information helps us to develop a more complete idea of how children organize their actions and thoughts. That information will ultimately help us to be better teachers of children.

I am looking forward to meeting you at the parent/staff information meeting to discuss the research with you and answer any questions. See you on ____________________________.

Thank you,

Margaret Griffin

Letter of Informed Consent

Dear Parent:

The classroom in which your child is enrolled has been chosen as one of several kindergarten and fourth-grade classrooms from which children will be selected to participate in a study of perceptual styles used by children. Each child in the study will be asked to complete two sets of exercises, the children's form of the Embedded Figures Test and three tasks involving matching blocks by sight and touch. An observer will watch each child complete the exercises and will record number of correct responses. Each child participating in the study will be identified by a code number, and no use of names will be made in any reporting of results. All materials that will be used in the study will be available at the school on ______________ at ___________ for your inspection.

If you choose to allow your child to participate in this study, you may review all data concerning your child at the close of the study. You are also free to withdraw consent for your child's participation at any time during the study. To do so, please inform the child's teacher in writing that you are withdrawing from the study. The teacher will inform the experimenters of your decision.

Any child participating in the study has the freedom to choose not to participate on his/her scheduled day. If this occurs, the child may choose to do the task on another day. If a child does not want to participate in the study, he/she will be dropped from the study. A decision to withdraw from the study by either parent or child will not affect the child's standing in his/her class.

A four-digit code number indicating grade, gender, and selection number of the child will be assigned to each child participating in the study. This number will be used to identify data associated with each child. There will be no record of children's names kept. No names of children will be used in reporting the study.

All phases of the study will be carried out at the school. It is estimated that the amount of time missed from class will be approximately 30 minutes. It is not expected that participation in this study will be either harmful or beneficial to the children in any way.

If you give consent for your child to participate, please read and sign the attached sheet and return to your child's teacher by ______________________________.

If your child is chosen by random drawing from those having parental consent to participate, you will be informed by ____________________.

Please keep this letter for your information.

Thank you,

Margaret Griffin

* * To give permission: detach, sign, and return this form to the teacher *

I have read the information sent to me concerning the study of children's perceptual styles being conducted at Lake Harbin Elementary School by Margaret Griffin. I give permission for my child ____________________ to participate in the study.
(name)

Signed______________________________

Relationship to child_______________

Date________________________________

Witness_____________________________

Dear Parent:

Your child ________________ has been selected by a random drawing from those children having parental permission to participate inthe study of children's perceptual/cognitive abilities being carried out by Margaret Griffin. Your child's code number is _________. You will receive a copy of the task scores obtained by your child at the end of the data-collection period. A complete report of the project results will be sent to the school in early summer.

Thank you for your cooperation.

Sincerely,

Margaret Griffin

Dear Parent:

The children have been randomly selected for the study of perceptual/cognitive abilities being carried out by Margaret Griffin. Your child was not one of those whose name was drawn. The selection process was a blind, random drawing from the names of all children who had parental permission to participate in the study. Selection was based on the luck of the draw and had nothing to do with the personal characteristics of your child.

Thank you for your cooperation.

Sincerely,

Margaret Griffin

APPENDIX C

CROSS-MODAL SENSORY TRANSFER TASKS

Numbering System[1] for Milton Bradley Geometric Solids
Used for Stimuli in Cross-modal Tasks

1. equilaterial triangular prism
2. right-angled triangular prism
3. square prism
4. hexagonal prism
5. octagonal prism[2]
6. cylinder
7. truncated cylinder
8. cone
9. frustum of cone
10. square pyramid
11. triangular pyramid
12. truncated cone
13. cone, plane parallel axis
14. cone, plane parallel one element
15. cube
16. cylinder, height equal to diameter
17. hemisphere
18. sphere[3]
19. rectangular solid, three dimensions different
20. oviod
21. ellipsoid
22. oblate spheroid

---

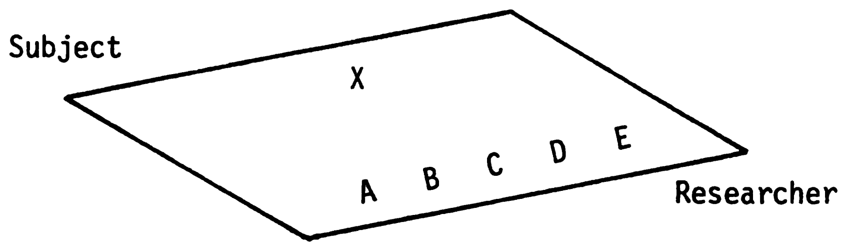
[1]This is the system devised by the Milton Bradley Company.

[2]This solid was not used because of its similarity to #4.

[3]This solid was not used because it rolled out of the "feeling box" too easily.

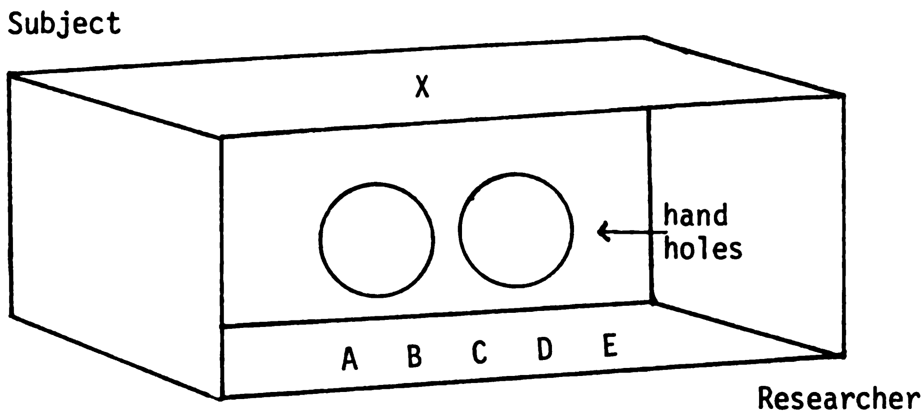
Positioning and Ordering of Stimuli Sets--Cross-modal Transfer Tasks

Task 1



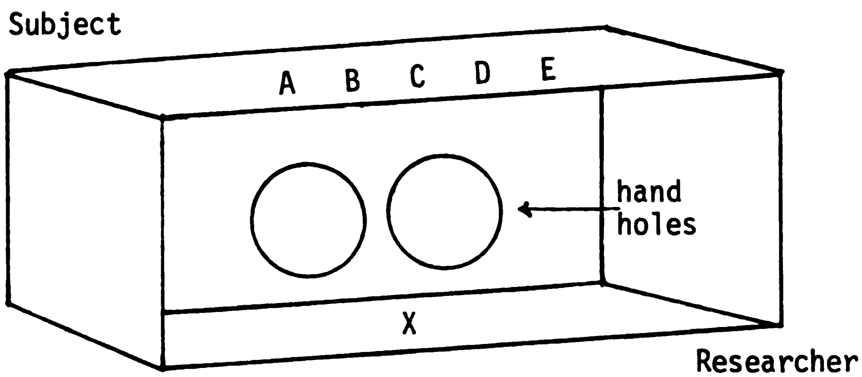
x = stimulus A-E = matching set

Task 2



x = stimulus A-E = matching set

Task 3



x = stimulus A-E = matching set

Positioning and Ordering of Stimuli Sets--
Cross-modal Transfer Tasks

Task 1

stimulus	matching set
a. 3	3, 11, 13, 19, 1
1. 4	7, 4, 17, 20, 9
2. 8	2, 7, 20, 8, 16
3. 11	11, 6, 14, 4, 22
4. 14	21, 1, 9, 14, 16
5. 17	6, 17, 8, 13, 10
6. 21	7, 16, 12, 11, 21
7. 2	10, 14, 2, 8, 20
8. 6	6, 13, 22, 19, 1
9. 9	1, 11, 17, 9, 12
10. 12	3, 12, 14, 20, 9

Task 2

stimulus	matching set
a. 2	14, 4, 21, 2, 16
1. 6	6, 8, 15, 10, 17
2. 9	22, 15, 9, 14, 11
3. 12	20, 12, 19, 3, 9
4. 15	2, 10, 12, 20, 15
5. 19	20, 14, 19, 4, 3
6. 22	22, 19, 17, 13, 4
7. 3	21, 10, 15, 3, 7
8. 7	20, 7, 11, 9, 16
9. 10	2, 7, 13, 15, 10
10. 13	21, 19, 13, 12, 1

Task 3

stimulus	matching set
a. 3	6, 12, 3, 22, 19
1. 7	1, 13, 21, 10, 7
2. 10	11, 10, 12, 17, 1
3. 13	7, 8, 13, 2, 15
4. 16	16, 17, 19, 4, 7
5. 20	22, 6, 1, 20, 15
6. 1	9, 1, 2, 3, 11
7. 4	6, 2, 12, 8, 4
8. 8	21, 14, 8, 17, 3
9. 11	11, 8, 16, 4, 12
10. 14	22, 15, 19, 14, 6

Cross-modal Transfer Tasks--Scoring Sheet

Subject code number ______ ______ ______ ______
(grade) (sex) (i.d.) (i.d.)

Task 1	Task 2	Task 3
a. _____	a. _____	a. _____
1. _____	1. _____	1. _____
2. _____	2. _____	2. _____
3. _____	3. _____	3. _____
4. _____	4. _____	4. _____
5. _____	5. _____	5. _____
6. _____	6. _____	6. _____
7. _____	7. _____	7. _____
8. _____	8. _____	8. _____
9. _____	9. _____	9. _____
10. _____	10. _____	10. _____
T = /10	T = /10	T = /10

Total Cross-modal Score = /30

APPENDIX D

CHILDREN'S EMBEDDED FIGURES TEST

SCORE SHEET FOR

CHILDREN'S EMBEDDED FIGURES TEST

NAME ______________________________

CLASS ______________________________

BIRTH DATE ______________________ SEX: M__ F__

DATE ____________ EXAMINER ______________________

TENT	DESCRIPTION	SCORE
P_1		
P_2		
T_1		
T_2		
T_3		
T_4		
T_5		
T_6		
T_7		
T_8		
T_9		
T_{10}		
T_{11}		
	Total Score TENT	

HOUSE	DESCRIPTION	SCORE
P_3		
H_1		
H_2		
H_3		
H_4		
H_5		
H_6		
H_7		
H_8		
H_9		
H_{10}		
H_{11}		
H_{12}		
H_{13}		
H_{14}		
	Total Score HOUSE	
	TOTAL TEST SCORE	

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APPENDIX E

DATA RECORDS

INDIVIDUAL DATA RECORD

Code number ______ ______ ______ ______
(grade) (sex) (i.d.) (i.d.)

Birthdate ____________________________

Racial/ethnic group __________________

CROSS-MODAL TRANSFER TASKS

1. Combined score _____
2. Task 1 score _____
3. Task 2 score _____
4. Task 3 score _____

CHILDREN'S EMBEDDED FIGURES TEST

1. Tent score _____
2. House score _____
3. Total score _____

REMARKS ____

____

____

PARENT REPORT SHEET--INDIVIDUAL CHILD DATA

Child's Code Number ______ ______ ______ ______
(grade) (sex) (i.d.) (i.d.)

CROSS-MODAL TRANSFER TASKS

1. Combined score _____
2. Task 1 score _____
3. Task 2 score _____
4. Task 3 score _____

CHILDREN'S EMBEDDED FIGURES TEST

1. Tent score _____
2. House score _____
3. Total score _____

APPENDIX F

CODE BOOK

CODE BOOK

Variable Name	Variable Label	Value Label	Columns	Format
ID	Identification	XXX	1- 2	F2.0
V1	Grade	1 = kindergarten 2 = fourth	3	F1.0
V2	Gender	1 = female 2 = male	4	F1.0
V3	Age	XXX	5- 7	F3.0
V4	Race	1 = white 2 = black	8	F1.0
V5	Combined score	XXX	9-10	F2.0
V6	Task 1 score	XXX	11-12	F2.0
V7	Task 2 score	XXX	13-14	F2.0
V8	Task 3 score	XXX	15-16	F2.0
V9	Tent score	XXX	17-18	F2.0
V10	House score	XXX	19-20	F2.0
V11	Total score	XXX	21-22	F2.0

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